INTRODUCTION

The status of the Internet has changed fundamentally during the past few years, particularly after the emergence of convenient Web browsers. Although this statement seems to be self-evident—one would even say that it is a cliché—it is an elusive statement as well. What has really happened? Internet traffic has exploded in such a way that it now surpasses the amount of telephony traffic in many parts of communication networks. Many extraordinary applications have found their place on the Internet. (Perhaps you bought this book from a virtual bookstore on the World Wide Web.) Email addresses are nowadays nearly as important as street addresses or telephone numbers.

However illustrative and valid this kind of assessment is, it does not provide proper guidance for the next steps in the evolution of the Internet. Thorough preparation requires a good understanding of the fundamental issues and a solid knowledge of the available tools for reaching this goal. This book strives to meet these requirements in a systematic manner.

Differentiated Services is one of the key concepts that can lead toward a more robust, more versatile, and more efficient Internet infrastructure. But this is a vast project that requires good planning:

1. Develop a robust technical basis that consists of the traffic-handling mechanisms—including queuing and scheduling systems implemented in network nodes.

2. Design a feasible network based on the nodes.

3. Devise the services provided to customers.

These tasks are complicated and need a solid understanding of traffic processes and network performance issues. This book addresses all these technical levels of Differentiated Services, and gives a lot of practical examples of how to optimally apply different mechanisms and methods.

The project is not finished when the technical issues are well resolved. Marketing the service to customers and keeping them satisfied enough that they are willing to pay for it is as

important as the technical realization. The history of telecommunications has shown that *this part of the project could be the main obstacle to success.* Therefore, this book focuses a lot of attention on evaluating the actual needs and expectations of ordinary users.

Who Will Benefit from This Book?

This book is intended both for readers who have knowledge of networking concepts and protocols and for readers who are more interested in the service aspects than the underlying technology. This book does not require a thorough understanding of communications technology or mathematical modeling, although both are used to explain the characteristics of different services.

This book is aimed at the following audience:

- Business and marketing managers at Internet service providers developing new Differentiated Services

- Engineers developing routers and other type of nodes for packet networks

- Operators responsible for the planning, operation, and management of the Internet and other packet networks

- Researchers, scientists, and students at universities and research institutes developing traffic-management systems for communication networks

Key Features of This Book

This book contains the following features that make it a practical guide for developing and implementing Differentiated Services:

- Concrete examples are highlighted throughout the book to demonstrate implementation and to anchor the abstract concepts in reality.

- Figures throughout the book illustrate technical issues and procedures. For easy access to the technical data, a table of all the figures appears at the beginning of this book.

- Tables convey crucial technical information at a glance.

- Numerous notes and sidebars are sprinkled throughout the text to provide information about tangential issues related to the principal topics.

- The glossary defines terms related to Internet traffic management. It is a handy reference to use when reading this book or working to implement Differentiated Services.

Organization of the Book

To expedite the learning process required in mastering Differentiated Services concepts and technologies, this book follows a three-part sequence of related topics—beginning with explanations of essential concepts and quickly moving to technical information and descriptions of solid implementation practices. The book's organization is described in detail in the following sections.

Part I: Background for Differentiated Services

Chapter 1, "The Target of Differentiated Services," defines the viewpoint of the book by introducing the primary building blocks of packet networks and the fundamental characteristics required by a feasible network service.

Chapter 2, "Traffic Management Before Differentiated Services," reviews the traffic-management principles applied in earlier networks. Concepts such as best-effort service in the current Internet, guaranteed services designed for the future Internet, and variable bit rate (VBR) service of ATM networks are explained and evaluated. Finally, this chapter discusses the target of Differentiated Services in relation to the advantages and disadvantages of the former approaches.

Chapter 3, "Differentiated Services Working Group," is reserved for the approach taken by the Differentiated Service Working Group of the Internet Engineering Task Force (IETF). Because of both the historical background and the status of IETF, the scope of the Working Group is carefully defined: IETF specifies only certain functions inside the network, but the design of the network services is left to service providers. In consequence, although the IETF specifications offer good basis for the implementation of Differentiated Services, they do not address all the necessary aspects.

Part II: Building a Network Domain Based on Differentiated Services

The ideas introduced in Chapter 4, "General Framework for Differentiated Services," fill the deficiency of IETF specifications. The framework provides a consistent view of the key aspects of Differentiated Services on traffic handling and network service levels.

In the future Internet with diversified services, the most prevalent expectation of customers could be high quality comparable to telephone service, or the affordability of the current Internet, or something else. These service and pricing issues are discussed in Chapter 5, "Differentiation of Customer Service."

Chapter 6, "Traffic Handling and Network Management," introduces the technical core of telecommunications networks: the mechanisms available to realize the desired services. You

must understand numerous concepts before it is possible to build a reasonable service. These concepts include such things as packet marking, traffic shaping, weighted fair queuing (WFQ), random early detection (RED), and bandwidth broker.

The first six chapters provide a good foundation for Chapter 7, "Per-Hop Behavior Groups," which evaluates the various approaches proposed within the wide scope of Differentiated Services.

Part III: Building Global Networks Based on Differentiated Services

Interworking is the main area of difficulty that can delay the realization of practical Differentiated Services. Chapter 8, "Interworking Issues," covers issues such as interoperability between a pure best-effort Internet and a Differentiated Services network; mappings between Differentiated Services and Integrated Services; and the implementation of Differentiated Services in ATM-based networks.

To get a realistic feel for what Differentiated Services can accomplish, Chapter 9, "Implementing Differentiated Services," provides several concrete examples in which different acute problems of the Internet are solved. There will be a lot of new things that are difficult to foresee, but I hope this book makes it possible to understand and, in the best case, anticipate the evolution of Internet services.